

dust could convey explosions should be repeated. It was to be noted in drawing conclusions from laboratory experiments, that the conditions obtaining in the mine were more favourable to the production of explosions, the temperature being higher and the air drier and denser. In conclusion he showed that the anticipated evils resulting from watering the mine do not occur.

Mr. Hall, in the course of his remarks, said the higher the quality of the coal, the greater was the liability to explosion. He hoped that it had been proved to the satisfaction of practical people that coal-dust and air alone were competent to produce explosion.

Prof. Thorpe said that in an explosion caused by flour-dust, which had reduced a mill to a heap of dislocated bricks, he had received an object lesson, which had quite converted him to the coal-dust theory. Experiment had shown him that coal-dusts varied greatly in their capacity of exploding; some will not explode under any conditions, while others he could at any time explode with certainty.

Mr. Stokes declared himself in favour of the second of the three opinions mentioned by Prof. Dixon. It should not be concluded that large amounts of gas could not rapidly accumulate in pits. In one mine, in which for four years no gas had been found, an evolution of gas took place which in twenty-five minutes was sufficient to fill the workings. The lamps being good, no explosion took place; had it done so, all the evidence would have been in favour of its origin being due to coal-dust. He looked for remedial measures in improved explosives and safety-lamps, rather than in watering, which he considered insufficient to more than moisten the surface of the dust, unless carried to an impracticable extent. Others having spoken, mainly in favour of the coal-dust theory, Prof. Dixon, in reply, said that he was glad that all mining engineers now seemed to recognise the dangerous character of coal-dust.

After the above discussion, Prof. Smithells showed by experiment that iodine vapour will glow on heating, supporting his contention that the luminosity of flame may be due to incandescent gas.

The papers on organic chemistry read at Nottingham were very few, viz.—“On the Red Colouration of Phenol,” by Dr. C. A. Kohn; “On the Salts of a new Sulphurea Base,” and “On Citrazinic Acid,” by W. J. Sell and T. H. Eusterfield; and “On Ethylbutane Tetracarboxylate and its Derivatives,” by Bevan Lean. In the course of the latter investigation two isomeric modifications of di-benzyl adipic acid have been obtained. The Report of the Committee on Isomeric Naphthalene Derivatives was read. The work done has been chiefly in connection with the orientation of mixed nitro and halogen derivatives.

The following pieces of apparatus were described, viz.—An Apparatus for Extraction for Analysis of Gases dissolved in water, by Edgar B. Truman, and a new form of Bunsen and Roscoe's Pendulum Actinometer, by Dr. Richardson and J. Quick.

GEOLOGY AT THE BRITISH ASSOCIATION.

OUT of the sixty papers contributed to this year's meeting of Section C. a considerable number, as might have been expected from the personal influence of the President, Mr. Teall, were on subjects connected with Petrology. Amongst this series, two of the most important were read by the eminent foreigners Prof. Brögger and Prof. Iddings, who had come over especially to attend this meeting. Next in number were the papers on Glacial Geology. The other papers group themselves into those on Local and Triassic Geology, Palæontology, Foreign Geology, and Vulcanology.

“On the Genetic Relations of the Basic Eruptive Rocks of Gran (Christiana region)” by Prof. W. C. Brögger.—This paper dealt with a series of eruptive bosses and laccolites forming a line of hills, of which the chief, in order from north to south, are (1) Brandberget, (2) Sölvberget, (3) Dignæs. The main rock type in these bosses was called by the author Olivine-gabbro diabase. It is basic (43 per cent. SiO_2) in 1, rather less basic (47 per cent.) in 2, and somewhat acid (49 per cent.) in 3; the more basic rocks were erupted first, then the less and less basic in order from north to south. From the intimate connection of the minerals in the different types, and the occurrence of all intermediate varieties, it was proved that these rocks had segregated in succession

from a magma whose average composition was not unlike that of the rock of Sölvberget. The gradation in chemical composition produced a similar gradation in the mineral percentages, the feldspar increasing from 12–64 per cent., and the pyroxene diminishing from 67–10 per cent. in a southerly direction. The author briefly stated that the contact metamorphism due to these plutonic rocks was quite different in character from that produced by a neighbouring mass of quartz-syenite on the same group of sedimentary rocks.

The eruptive bosses are accompanied by a great series of dykes and sheets of lamprophyric character, and varying from Camptonite to Bostonite. The author brought forward a quantity of evidence to prove that (1) these two extreme types, with silica percentages ranging from 40–56, had been derived from the same magma; (2) that 9 parts of Camptonite and 2 of Bostonite (about the proportion observed in the field) would give a magma of the composition of the Olivine-gabbro-diabase of Sölvberget; (3) that these lamprophyric dykes had been derived from the same magma as the plutonic rocks; and (4) that the differentiation had been effected while the magma still remained fluid. It was further shown that the differentiation was probably due to the migration of less soluble constituents to the cooling margin, that the Camptonites had a composition closely allied to that of the brown hornblende of the area, and that while the essential cooling of the plutonic rocks had taken place in the eruptive bosses themselves, the dyke rocks had segregated before extrusion.

A subsidiary differentiation has taken place in some of the plutonic rocks, giving rise in the more basic Brandberget to a pyroxenite (with 95 per cent. of pyroxene) and augite-diorite, and in the less basic Sölvberget to pyroxenite and Labrador-porphyrite.

Other points of importance to be noted were: (1) That under different physical conditions not only various mineral aggregates, but rocks of varying chemical composition had resulted from the crystallisation of the same magma; (2) that similar products result in this case from the segregation of an Olivine-gabbro-diabase magma, as have elsewhere been derived from a magma that has produced nepheline-syenites; (3) that the direction of segregation according to laws of crystallisation throws considerable light in the order of volcanic eruptions from neighbouring centres.

“On the Dissected Volcano of Crandall Basin, Wyoming,” by Prof. J. P. Iddings. This paper was divided into a strictly petrological portion, and one dealing more broadly with the features of the area, and illustrated by slides brought over for the purpose by Prof. Iddings. The palæozoic and mesozoic deposits, almost unbroken up to the Laramie, had been disturbed and eroded before the outbreak of this volcano, now represented by lavas and breccias, penetrated by radiating dykes, and a core of crystalline rock, which is surrounded by a chaotic mass of scoriaceous breccia and massive flows. Erosion has removed at least 10,000 feet from the summit of the volcano, and has cut 4000 feet deeper into the valleys on either side of the centre. The lower breccia contains several varieties of andesite, the upper is chiefly basaltic, which is also the character of the chief massive flows. The dyke rocks are on the whole more crystalline, and contain biotite to the almost total exclusion of the olivine of the lavas and breccias. The core is chiefly of gabbro, which, however, passes into diorite, and even to aplite; these highly acid rocks appear to be amongst the latest of intrusions, but are cut by a few dykes of lamprophyric basic rock, which are also represented in the flows outside the core. The author's investigations show that under different circumstances totally different mineral aggregates arise from the cooling of the same magma. The basalts containing plagioclase, augite, olivine, magnetite, and sometimes hypersthene, the gabbros, plagioclase, augite, hypersthene, and biotite, besides some magnetite, orthoclase, and quartz, with or without hornblende. Further, the coarseness of crystallisation in the core and dykes seems to have been more influenced by the temperature of the surrounding rock than by the pressure to which they were subjected.

“On Structures in Eruptive Bosses which resemble those of ancient Gneisses,” by Sir Archibald Geikie. He thought Lehmann's theory of the dynamical origin of foliation might explain granulitic gneisses with thin folia extending uniformly over a large area, but was inadequate to explain coarsely banded masses of irregular composition. These were better compared with the structures visible in the deeper parts of eruptive bosses

in which minerals were segregated into bands, often parallel, and containing one prominent mineral in large crystals. Pegmatite veins, traversing not only massive unfoliated rocks, but the segregated bands, also occurred. These structures were best seen in ancient plutonic masses, but had also been lately observed by the author in the recent volcanic rocks of the Western Isles of Scotland.

On "Berthelot's Principle applied to Magmatic Concentration," by A. Harker. The paper deals with that type of concentration in which an igneous rock-magma, supposed originally homogeneous, has been differentiated by accumulation of the more basic ingredients in the cooler marginal part of the liquid. The author tries to find a physical cause for this action by comparing such a magma with a *saturated* saline solution, and applying Berthelot's "principle of maximum work" or the cognate one of "most rapid degradation." The migration of the least soluble ingredients to the part of the liquid most easily saturated would determine crystallisation, the process which in the case supposed would give the most rapid evolution of heat.

On "The Igneous Rocks of Barnave, Carlingford," by Prof. W. J. Sollas. The white granophyre of this tract is intrusive into a black gabbro, in dykes of all sizes down to the most minute films and specks amongst the constituents of the latter rock. The result of this intimate intrusion is to convert the gabbro locally into a quartz gabbro, whilst the granophyre is loaded with fragments varying from large masses to crystal dust derived from the fracture of the gabbro, thus becoming a hornblende granophyre. These intermediate rocks have been made out of a mixture of acid and basic constituents. The same author gave an analysis and microscopical description of an intrusion of Amphibolite at Glendalough, which, at its margin, had been transformed into Quartz-mica-diorite by the action of veins which were filled with potash felspar in the hornblende rock, but with quartz in the adjacent schists. Both these papers were well illustrated by lantern slides. Prof. Sollas also exhibited some pebbles from an ancient consolidated beach at Sandymount, co. Dublin, which had impressed one another on account of the perpetual jarring of the tram-cars running over them. He thought it was likely that earth tremors had had considerable influence in producing the similar pittings in Triassic pebbles. Bearing on this subject Dr. V. Ball showed incised bones and antlers from Irish peat-bogs, the cuts on which were due to pressure and tremors passing through the bog.

There were two papers, by Mr. W. W. Watts, on Irish petrology; one, "On a Hornblende-Pikrite intrusive in Cambrian Rocks at Greystones, co. Wicklow," described a rock consisting mainly of green and colourless hornblende enclosing grains of olivine, now converted into a mineral-like colourless amphibole; and another, "On the Perlitic Quartz Grains in Rhyolite of Sandy Braes Quarry in Antrim," in which the porphyritic quartz grains exhibited a series of concentric cracks, perlitic in character, the bulk of which were confined to the quartz crystals, but some of which traversed quartz and matrix alike.

"On Augen-Structure in Relation to the Origin of Eruptive Rocks and Gneiss," by Mr. J. G. Goodchild. Passing over that type of this structure more properly named phacoidal, the author confined himself to those "eyes" of minerals which have grown *in situ* in the rock where they occur. In cases where the original rock contained the necessary material for the formation of the "eyes," a rise in temperature or relief in pressure sufficient to enable the less refractory minerals to aggregate, but not sufficient to alter the chemical and physical state of the matrix, appears to have been all that is necessary. In other cases the author suggested that the necessary alkalis for the formation of such substances as secondary feldspars may have been derived from the inner zones of the earth's crust.

A very useful and well-illustrated paper was read by Mr. Arnold-Bemrose, "On the Derbyshire Toadstone." There are two, at least, and may even be three or four, beds of olivine dolerite associated with tuffs. The rock is columnar and spheroidal, and may frequently be met with in an undecomposed state when the augite occurs in grains or ophitic plates containing feldspar or olivine. There appears to be no foundation for the supposition that the toadstone contains no lead ore. All these rocks are surface lava flows.

Messrs. Howard and Small divide the igneous rocks of South Pembrokehire into a northern group of rhyolites associated with quartz diorites and granites, often gneissose in character, and with epidiorites and hornblende schists, and a southern

group at Musclevick Bay, consisting of porphyrites and dolerites in connection with a rock like a soda felsite. The authors are unable to fix the age of the rocks, but think the evidence goes to show that the rocks are, at the earliest, of Post-Silurian date.

Amongst the local papers, one by Prof. Clowes was of considerable interest. In it he showed the rock of which Bramcote and Stapleford hills and the Himlack stone were composed, was cemented by barium sulphate present occasionally in such quantity as to make 50 per cent. of the whole rock. Sometimes the crystalline cement was evenly distributed in minute crystals, but at others it was aggregated into patches which made the rock weather unevenly, so as to produce the so-called "pebble sand-beds." The author had no evidence of the form in which the cement was originally deposited—whether as carbonate or directly as sulphate.

Prof. E. Hull pointed out that the Nottingham water supply was derived from the Bunter sandstone, which was underlaid by the impervious Permian marls. Allowing that 20 out of 30 inches percolated into the sandstone, he calculated that the area of its outcrop from Worksop to Nottingham (120 square miles) must receive 40,000,000 gallons, all of which tends to flow eastwards. From the three stations about 5½ million gallons were pumped daily. In a note on "The Borings at Netherseal Colliery," Prof. Hull determines the lowest rocks reached under Trias and Coal Measures at a depth of about 770 feet from the surface, as grits, sandstones, and quartzite, and attributes to them a Lower Cambrian age.

A number of more or less local papers relating to the new red sandstones were grouped together. Prof. Lapworth gave a general account of the subdivisions, distribution, and thickness of these rocks in the Midlands. Mr. Irving followed with *arésumé* of his researches for twenty years into the younger red rocks, referring to the classing of the Devonshire igneous and lower stratified red rocks as Permian in the recently published index maps of the Geological Survey. Mr. Metcalfe gave a note on the Gypsum deposits of Notts and Derbyshire. Baron von Reinach and Mr. Ussher recorded the discovery of Upper Magnesian limestone shells at Bulwell, and Messrs. Kendall and Gray showed that the presence of Permian marls at Stockport destroys the supposed evidence of unconformity there between the Permian and Trias.

After a brief discussion on Geological Education, Tuesday was devoted to glacial papers and discussion. Mr. Dugald Bell read an abstract of a most careful and important investigation into the shell-bearing clays of Clava in Nairn. The section in descending order, proved by excavation and boring, is as follows:—

	Feet.
(1) Surface soil and sandy boulder clay ...	43
(2) Fine sand ...	20
(3) Shelly blue clay with stones in lower part ...	16
(4) Coarse gravel and sand ...	15
(5) Brown clay and stones ...	21½
(6) Solid rock, Old Red grit ...	...

The highest part of the shelly clay is 503½ feet above sea level, and the deposit appears to be continuous for a distance of 190 yards. It contains far-travelled, well-rounded stones (one must have come at least twelve miles) associated in different proportions from those in the overlying boulder clay or underlying gravel. The shells are mainly littoral, though some may have lived at depths not greater than twenty fathoms; although not intensely arctic, they indicate a colder climate than the present. The shells are well preserved, neither rubbed nor striated, and the deposit is a true marine silt, which if not *in situ* must have been transported in mass. The direction of ice flow being from south, or a little west of south, shows that the ice did not pass over any existing sea-bed before reaching Clava, and if the clay was carried from Loch Ness a submergence is postulated by the marine fauna there. The majority of the committee consider the evidence sufficiently strong to prove a submergence to the extent of 500 feet, and they think the passage of ice to form the upper boulder clay would be sufficient to cause the cracking of the shelly clay and the crushing of certain of the shells. Detailed reports and lists of organisms are given, and a "minority report" on the evidence bearing against the view put forward above. Mr. Bell, in a paper, commented on shelly clay and gravel extending along the east coast of Aberdeenshire from the sea level up to about 300 feet, and endeavoured to explain it

by the formation of lakes owing to the blocking of transverse valleys by the passage of ice across their mouths. In another paper the same author connected the granite boulders found in the Clyde Valley about Glasgow and Gourrock with the mass of plutonic rocks occurring between the heads of Lochs Fyne and Lomond, and supposes them to have been brought by ice coming through Loch Fyne and Holy Loch, Loch Sloy, Loch Long, and the Gareloch, and in much smaller numbers by Loch Lomond.

Prince Kropotkin summed up his knowledge in the general glaciation of Asia. The Lowlands and Steppes, under 2000 feet in height, do not appear to have been glaciated; but all the mountain ridges rising over the steppes, the great border ridges like the Tian Shan, and the Alpine tracts fringing the plateau were covered with immense glaciers, which descended to within 1000 feet of the sea level. The Vitim Plateau, the N.W. Mongolia Plateau, the Pamirs, and the Great Khingim were extensively glaciated. The southern portion of the High Plateau, however, yields only indirect and not conclusive evidence of glaciation.

Prof. Sollas exhibited a large map, and gave an account of the Esker Systems of Ireland. Eskers have always been difficult to explain, and the best explanations have called in deposit by rivers; the difficulty has been to account for the disappearance of their banks. Prof. Sollas suggests that the sustaining walls may have been of ice, and that eskers are practically "casts of a glacial tunnel in gravel and sand." The eskers of Ireland are like rivers in their windings, and in the reception of tributaries at an acute angle. Deducing from the eskers the ancient drainage system of the Irish glaciers we find a smaller set draining from the glaciers of Sligo and Roscommon, and a much more important set, embracing the whole central plain, escaping by the valley of the Liffey.

Mr. C. A. Lindvall, of Stockholm, reviewed the principal theories to account for the origin of the glacial period, and proposed to account for it by the partial submergence of Northern Europe to form an archipelago, through which escaped the cold ice-bearing currents from the Arctic Ocean. The author further endeavoured to show that the drifting of pack ice is sufficient to account for the striation, eskers, boulders, and other glacial signs in Scandinavia, Switzerland, and Scotland.

Prof. Bonney read a paper which gave rise to brisk discussion, in which Sir H. Howorth, Mr. Lamplough, Mr. Kendall, and others took part. He denied that there was any proof of considerable ground moraines in connection with existing glaciers, that glaciers were potent excavators, and that there was any evidence to show that ice had the power to scoop loose material from a sea-bed and pile it up from above the water-level; he suggested that boulder-clays like those of Britain, so different from Swiss moraines, may have had more than one origin.

Messrs. Abbott and Kendall have found shell middens with *Cardium edule*, a sheep's tooth, bird bones, and charcoal, at "The Quinta," on Penmaenmawr, and in the Aber Valley; they consider them due to human agency. Mr. Cameron described a mass of chalk, about a mile long, embedded in boulder clay at Catworth, in Huntingdonshire. Mr. De Rance concluded that the rock valleys of Lancashire and Cheshire were scooped by fluvial agency when the land stood 300 feet higher than at present, and many of them are now choked with glacial detritus extending far into the Irish Sea. The so-called inter-glacial gravels do not occur on one horizon, and often several such beds are passed through in succession; they are regarded as having been partly formed in freshwater lakes and partly under the ice.

In the subject of palæontology three reports were presented. Prof. T. Rupert Jones described two species and two varieties of *Phyllopora*, and made corrections, suggestions, and criticisms of other work; Mr. Laurie and Mr. Smith Woodward reported that progress was being made in working out the Eurypterids of the Pentlands, and in the registration of type specimens of fossils respectively. Dr. Traquair recorded *Cephalaspis* (*C. magnifica*) for the first time from the Orcadian area of the Old Red Sandstone; the cranial shield of this form, the largest known, is not less than 8½ inches in length. Mr. E. T. Newton gave a concise account of the Reptilia of the British Trias, including a notice of two entirely new forms, one related to *Stagonolepis*, the other a form intermediate between the crocodiles and dinosaurs. Mr. R. B. Newton recorded the first known shells from the English Keuper, discovered by Mr. Brodie and Mr. Richards in the marl of the Upper Keuper Sandstone of Shrewley, Warwick-

shire. They are referable to new species of the genera *Thracia*, *Goniomya*, and *Pholadomya*, and are associated with *Acrodon* and *Estheria*. Prof. Sollas gave a careful and illustrated description of the minute anatomy of *Monograptus priodon*, gathered from exceptionally perfect specimens; three layers are visible, the middle one being reticulated and thickening out to form the virgula and at the free edges of the thecae. Mr. Montagu Browne referred several bones and teeth of *Terminosaurus albertii*, and of undetermined species of *Plesiosaurus*, to *P. rostratus* (Owen), from the Rhætic; he considered that the teeth of several species of *Saurichthys* would have to be divided between fish and labyrinthodonts; he also recorded the discovery of *Ceratodus* from the Rhætic.

In a clear and well illustrated paper by Mr. Walcot Gibson "On the Geology of Central East Africa" there is a description of the fringing reef bordering the land at Mombasa, succeeded by inland reefs rising up to 100 feet; the latter rests on a sedimentary series containing ammonites and ichthyosauria, and in turn resting unconformably on a great metamorphic series of gneisses, schists and intrusive granites, which occupy an area of fully two-thirds of Central East Africa. The remainder of the country is formed of recent volcanic rocks, forming great cones like Kilimanjaro, or arranged in lines running north and south. Most of the volcanoes are dormant or extinct, and none appear to be of great geological antiquity. Mr. R. D. Oldham exhibited geological maps of India on the scales of 96 and 32 miles to the inch, showing the recent work of the Geological Survey of that country; the smaller-scale map is to be published with the "Manual of the Geology of India." Mr. Myres showed that the fundamental rocks at Caria were crystalline, quartzose, and felspathic rocks with obscure foliation, traversed by dykes and necks of two ages, one pre-Cretaceous, which have supplied the volcanic rocks underlying the great mass of Cretaceous limestone, and the other from which the Tertiary volcanoes proceeded. The Cretaceous rocks were eroded before the deposit of the Tertiary shore beds, which pass away laterally into limestones; these beds are roughly correlated with those of Rhodes and Crete. Galena, pyrolusite, and a cobalt mineral are found in the ancient rocks.

Amongst the other papers it is only necessary to notice the following briefly:—Mr. Fowler described a fault at Cinder Hill, which causes greater displacement in the Carboniferous than in the overlying Permian rocks. Dr. Hicks pointed to the fragment in basal Cambrian rocks as indicating older series in Wales; Mr. Fox noted the wide extension of radiolarian chert in Cornwall; Mr. Bolton gave an account of the Skiddaw slates of the north of the Isle of Man, which had yielded rare trilobites and *Dictyonema*; Mr. Woodward's discovery of a bed of iron-ore on the horizon of the Cleveland iron between the middle and upper Lias of Raasay; Prof. Herdman's note on a consolidated shelly sand-bed from the bottom of the Irish Sea; Prof. Milne's illustrated account of volcanic and earthquake phenomena in Japan; Dr. Johnston Lavis's record of the condition of Vesuvius during the year, and his interesting note on the production of emerald-green augites by the action of enclosed particles of quartz and quartzite on a lava of Stromboli; Mr. Jeffs' list of geological photographs (140 in number) received during the year; Mr. De Rance's report on the circulation of underground water; and Mr. Kendall's report on erratic blocks, including the detailed survey of boulders in some considerable areas of the North of England.

In addition to the papers above reviewed, Section C took part in two discussions with other sections, and held one on its own ground. Mr. Topley, Prof. Bonney, Dr. Ball, Dr. Roberts, and Prof. Lapworth were the chief speakers on the limits of geology and geography; Prof. Sollas, Prof. Bonney, and Dr. Rothpletz, on the subject of coral reefs. The discussion on geological education was led by Prof. Cole, in a lucid paper on "Geology in Secondary Education," in which he advocated that, as a branch of history, geology should be taught to all secondary students. He advocated practical teaching so far as possible, and especially an acquaintance with the life history of the globe. Prof. Lebour, following, insisted on the careful selection of subjects in professional education and on the importance of making every part of the teaching as practical as possible, and encouraged experiments and field work, which he thought might very well be aided from the County Council's Technical Education Grant. These ideas were enforced by a number of subsequent speakers.

A word must be given to the series of photographs exhibited

by the Photographs Committee, of which, however, only a small selection could be shown, those exhibited by the Scottish Geological Survey, and the specimen slides and maps to illustrate papers and discussions, kindly lent by Prof. Sollas, Messrs. Teall, Topley, Johnston Lavis, Gregory, and many others. This exhibition, if it can be continued with increased facilities at subsequent meetings, promises to become one of the most important features of the section's meeting

EVOLUTION AND CLASSIFICATION.¹

AS we have gathered up the scattered masses of botanical knowledge, laboriously wrought out by many isolated workers, and attempted to fit them together into a consistent whole, which should outline the structure of the temple Botany, we have found that the workmen have not always followed the same architectural plan, and have often used different units of measurement. With the increasing specialisation so noticeable year by year there is a corresponding lack of coordination of work. To this lack of coordination, this want of unity of measurement, this misunderstanding of plan, we can no longer close our eyes, and I therefore feel free to invite your attention to the following somewhat summary discussion of the causes of the present unsatisfactory condition, in the hope that we may thereby be enabled to see how we may make some improvement.

All botanical knowledge finally culminates in some kind of classification. The facts of histology, morphology, and physiology are of great biological importance, but the greatest of all biological facts is that the world is peopled with living things. We may group and arrange in orderly sequence the histological facts of the science; we may do likewise with the facts which the morphologist has discovered; we may make a classification of all the known physiological facts; but beyond and above these lies the greatest grouping of all—the grouping in orderly sequence of the organisms themselves whose histology, morphology, and physiology we have studied.

It is now a full third of a century since a great light was first turned upon all biological problems by the formulation of the doctrine of evolution by the master-mind of Darwin. In its light many puzzles have been solved, and many facts hitherto inexplicable have been made plain. We now know what relationship means, and we have given a fuller meaning to the natural system of classification. From the new point of view a natural classification is not merely an orderly arrangement of similar organisms. It is an expression of genetic relationship. Furthermore, in the light of evolution we now see the meaning of many reduced structures whose significance was formerly not at all—or but vaguely—understood. We have become familiar with the fact that degradation is a prominent factor in the vegetable kingdom. Evolution has by no means always involved an advance in structural complexity. Often this catagenesis is a result of parasitism or saprophytism, as is so well illustrated in the "fungi," where the degradation has gone so far that their relationship has to a great degree been obscured.

But there are also many cases of a catagenesis not due to a dependent habit in which we have evidence of a simplification from a more complex structure. Thus in the willows and poplars, where we have a raceme of very simple flowers, each consisting of a single ovary, or one to many stamens, it is readily seen that this simplicity is not primitive. The ovaries are not single carpels, but are composed of two or three united. The flower of the willow is simple by a degeneration from a higher type—probably a tricarpeillary or pentacarpellary type—by the loss of its floral envelopes and stamens or pistils.

Every naturalist should be as familiar with these illustrations of evolution by simplification as he is with those of evolution by complication. In the growth of the great tree of life, while the development has been most largely in an upward direction, so that the great body of the tree has risen far above its point of beginning, there are yet multitudes of twigs and branchlets which droop downward.

I need not now, before a body of scientific men, speak of evolution as an hypothesis; for we know it as a great biological

fact, about whose existence there is no shadow of doubt. A natural classification will conform strictly to the lines of evolution, it will be in fact a clear exposition of the successive steps in its progress. In such a classification the primitive forms will precede the derived ones, and the relation of the latter will be positively indicated. Moreover, in such a system there will be no confusion between the primitively simple forms and those which are so by derivation.

An examination of our common systems shows them sadly deficient in the essentials of a scientific classification. This is particularly true of the treatment of the flowering plants at the hands of English and American botanists. Nothing could show better the conservatism of botanists than the fact that for a third of a century after the general acceptance of the doctrine of evolution they are still using so crude an arrangement of the group of plants with which they are most familiar.

I may assume that it is well known to nearly all of us that the prevailing arrangement of the Dicotyledons does not represent the later views of any of the systematists. The fact is that the systematic disposition of the higher plants is at present a make-shift, maintained by conservatism, and a reverence for the time-honoured work of the fathers. It is unscientific to let our practice drag behind the present state of our knowledge: it is far more so for us to cling to the opinions of our fathers, through mere reverence, long after we know them to be untenable. It is not to the credit of our science that for a second time she has persistently held to a system through such considerations. For thirty or forty years after a natural system had been constructed by Jussieu, botanists as a body still adhere to the artificial system of Linne. Now, sixty years later, we find ourselves faced with a problem similar to that which Lindley, Torrey, Beck, and Gray met. History repeats itself with such exactness that, with the change of a word here and there, the arguments *pro* and *con* then used may be used to day. The system of Jussieu and DeCandolle is now as much a clog and a hindrance to the systematic botany of the higher plants as was that of Linne sixty years ago, and now as then it is the spirit of conservatism and of veneration for time-honoured usage which maintains the incubus.

Manifestly a system of classification which conforms to and is based upon the doctrine of evolution must begin with those forms which are primitive, or which as nearly as may be represent primitive forms. Since the flower is a shoot in which the phyllomes are modified for reproductive purposes, that flower in which the phyllomes are least modified must be regarded as primitive, while that in which there is most modification must be regarded as departing most widely from the primitive type. The simple pistil, developed from a single phyllome, is primitive and lower, the compound pistil is derived and higher. The several seeded compound ovary must be lower, and the compound ovary with but one seed must be higher. Separate stamens are primitive, united stamens, whether the union be with one another or with other structures, must be derived and consequently higher. So, too, when all parts of the flower are separate it is a primitive condition, and when they are united it is a derived structure.

Applying these principles to the flowering plants it becomes evident that in the Dicotyledons either the Apetalæ or the Polypetalæ must furnish our starting point. The Gamopetalæ are universally admitted to be higher than the groups just mentioned, and certainly do not contain the sought for primitive types. Even a hasty examination of the thirty-six apetalous families shows that they are, at least to a very large extent, derived from the Polypetalæ by the abortion of some parts and the entire omission of others. It will not be difficult to determine that the Ranales must take rank below all other Polypetalæ, in the sense of representing more nearly than any other group the primitive Dicotyledons.

The attempt to make a natural system by linking family to family in a long undulating chain, by concatenation, is unscientific because it absolutely fails to conform to the law of evolution. We must abandon the old classification and attempt one which in the light of evolution is rational. Let us not cling to the old because it is inconvenient to change, let us not cling to it through a mistaken reverence for the practice of the fathers, let us not cling to it as long as a flaw may be found in a new system. Science is ever abandoning the old when the old is no longer the true; it tears down the work of years when that work no longer represents the truth; and it dares to reach

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